

FIRE SUPPRESSION EFFICIENCY SCREENING USING A COUNTERFLOW CYLINDRICAL BURNER

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ABSTRACT

The recent ban on halon 1301 (CF_3Br) production (as a result of its ozone depleting potential) has resulted in extensive search for its replacements and alternatives. The applications of fire suppression efficiency screening methods constitute an important aspect of this search process because good screening methods can facilitate the identification, comparison, and selection of potential candidates for halon replacement. Most of the current methods for fire suppression efficiency screening (e.g., cup burners) are designed for evaluating fire suppressing agents that can be delivered in the form of vapor. Potential uses of liquid agents as replacements have been recently proposed in several applications (e.g., shipboard machinery spaces, engine compartments in armored vehicles). Therefore, there is a need for the development of a reliable screening method for liquid agents that can be delivered in droplet form. The objective of our current work is to design, construct, and demonstrate a laboratory-scale apparatus that can perform the screening of liquid agents in a well-controlled experimental setting.

A counterflow cylindrical burner is selected. This kind of burner has been extensively used in the past to characterize flame extinction and suppression using inert gases, halons, and powders (sodium bicarbonate and Purple K) due to the ease of maintaining a stable flame over a wide range of fuel and oxidizer flows and the ease of introducing condensed phase materials in the carrier (oxidizer) stream. The burner, which is made of sintered stainless steel and water-cooled, is located in the test section of a vertical wind tunnel. Air is supplied to the tunnel via a frequency-controlled blower and a myriad of flow straighteners. Propane is used as fuel. A piezoelectric droplet generator is used to create liquid droplets ($< 250 \mu\text{m}$) from controlled breakup of jets emerging from a multi-orifice plate. A Phase Doppler Particle Analyzer (PDPA) is used to measure droplet sizes, velocities, and number densities near the flame zone.

The stability limits of the burner were mapped using various fuel and oxidizer flows. The stability envelopes compared favorably with those reported in the literature. The screening apparatus was characterized using inert gases (argon, helium, and nitrogen) which were gradually added in the oxidizer stream until extinction occurred. The relative fire suppression efficiency ranking of these three gases was found to be commensurate with that from cup-burner tests. In all the experiments, extinction is defined as the conditions when blow-off occurs (an abrupt transition from a stable enveloped flame to a wake flame). For liquid droplet experiments, the oxidizer flow (with fixed droplet generation and fuel flow) is gradually increased until extinction (blow-off) occurs. Suppression experiments using pure water and water with an additive will be presented and discussed.